## Synopsis of the "Mars Dogs" Pilot Project at LBNL

T. Budinger
K. Brennan

One of the few experiments conducted with charged particles on large animals is an ongoing study by Drs. Thomas Budinger and Katie Brennan of the Lawrence Berkeley Laboratory. A brief synopsis of this work was provided by Dr. Brennan and presented to the workshop along with an invitation to participate in the final analysis of the canine samples. The letter is included below and is followed by the project synopsis.

Dear Drs. Fike and Nelson:
Dr. Tom Budinger asked that I give you a synopsis of our work on heavy ion irradiation in the canine brain, which I've described below. We will be finishing up this project over the next few months and we would greatly appreciate your input on what we should do in our final histo-pathological analysis to make it as complete and useful as possible. Thanks very much in advance for your help!

Project Synopsis

A ground-based pilot experiment was initiated in December 1992 to evaluate the long-term effects on health and aging after HZE cosmic radiation of the canine brain. Six adult male beagle dogs (approximately 1 year of age) from the UC Davis (UCD) breeding colony at the Laboratory for Energy Related Health Research are being researched in this study.

Iron nuclei at 600 MeV/amu (180 keV/um) were used to irradiate the whole brain. The fluence of $3 \times 10^6$ iron nuclei/ $cm^2$ mimics the HZE exposure (all > HE ions) for a two-year mission to Mars. The HZE irradiation was a fully stripped iron particle beam at the LBNL Bevalac. Using a Raster Scanner we were, however, able to spread the beam to deliver a uniform dose over the brain. The total dose to the brain was 200 cGy.

Four dogs were whole brain irradiated with iron and two dogs served as litter-mate controls. The control dogs were not irradiated but were in the same room during a dog brain irradiation so that the control dogs received a similar amount of background neutron irradiation as experienced by the four brain-irradiated dogs.

Yearly PET metabolism and MRI studies have been done on these dogs' brains since irradiation. Additionally, all dogs have yearly physical and neurological exams as well as complete blood work-ups.

PET imaging is performed with the Donner 600-crystal high-resolution positron tomograph with 2.6 mm resolution and with the lower resolution commercial PET CTI/Siemens ECAT 951 PET Scanner (5 mm resolution).

NMR Imaging is performed with the 1.5T GE Signa at UCSP using TI imaging sequences and spoiled gradient sequences at 1 mm resolution. A major goal of this work

is to present an accurate method for measuring surface areas and volumes of the irradiated vs. the non-irradiated canine brain using MRI data, which are isotropic in resolution at the 1 mm level. This allows us to monitor the changes in brain size with aging and radiation exposure.

We will perform final imaging studies on these dogs early in 2001 and subsequently the dogs will be sacrificed for a complete histo-pathological work-up by a team of experts we are in process of assembling. Your help in finalizing this protocol will be appreciated.

Reference of Previous Work

Brennan KM, Roos MS, Budinger TF, Higgins RJ, Bristol KS, Wong STS. PET and MRI Results in the Study of Radiation Necrosis and Edema in the Canine Brain. Radiation Research 1993 Apr. 134(1):43-53.